SHORELINE CHANGES IN THE TIMBALIER BARRIER ISLAND ARC- 1887 TO 1996 TERREBONNE PARISH, LOUISIANA

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INTRODUCTION

The U.S. Geological Survey (USGS), in cooperation with the Coastal Research Laboratory in the Department of Geology and Geophysics at the University of New Orleans (UNO) and the Center for Coastal Energy and Environmental Resources at Louisiana State University (LSU), is investigating the processes of coastal erosion and wetland loss in Louisiana (Sallenger and others, 1987; Sallenger and Williams 1989; Penland and others, 1992). Building on the USGS Louisiana Barrier Island Study (Williams and others, 1992), this USGS Open-File Report depicts shoreline changes between 1887 and 1996, which provides an 8.9-year update of McBride and others (1992).

The Timbalier Islands are located about 100 km south-southwest of New Orleans (Figure 1). This barrier island shoreline is 30 km long and extends east from Cat Island Pass to Raccoon Pass. The Timbalier Islands represent a flanking barrier island system developed from the reworking and erosion of an abandoned distributary of the Lafourche delta complex within the Mississippi River delta plain (Penland and others, 1988). Island evolution is driven by predominant longshore sediment transport and storm overwash, causing the island arc to migrate to the north and west. The present configuration of the Timbalier Islands consists of Timbalier Island to the west, Timbalier Shoal, and East Timbalier Island to the east. Timbalier Shoal, located between the two islands within Little Pass Timbalier, is a transient area of moving sand, which is subaerial for some periods of measurement. The Gulf shoreline of East Timbalier Island has been armored by a rock seawall with a second seawall constructed landward in an attempt to protect oil and gas facilities on the bayside.

In order to quantify shoreline changes since January 21, 1988, new vertical aerial mapping photography was acquired on December 9, 1996 The methods and transects used by McBride and others (1992) were used to insure data compatibility of the new measurements and analysis (Plate 7). Table 1 presents the transect measurements of shoreline change for the Timbalier Islands. For gulfside change measurements, a negative (-) sign signifies landward movement or erosion and a positive (+) sign signifies a seaward movement or progradation. For bayside change measurements, a negative sign signifies a seaward movement or erosion and a positive sign signifies a landward movement or accretion

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Island evolution is predominantly driven by longshore sediment transport and storm overwash, causing the island arc to migrate to the north and west while slowly losing total area. Storm overwash predominates along East Timbalier and Timbalier Shoal, while longshore transport dominates at Timbalier Island. The highest rates of erosion occur on the eastern ends of each island and lessen along the Gulf shoreline toward the west. The bayside of the islands experiences edge-erosion caused by wave action from Timbalier Bay to the north. For long-term comparisons, area change data is more meaningful than lateral shoreline retreat along the Timbalier Islands because of the high rate of island migration. Island area has been significantly reduced by periodic severe freezes which killed extensive areas of black mangrove swamp, and hurricanes which significantly altered the landscape in a short amount of time.

Between 1887 and 1996, shoreline change was dramatic along the entire length of the Timbalier barrier island arc (Plate 6). The land areas shifted by island migration so that many transects yielded meaningless data.

GULFSIDE SHORELINE CHANGES

In terms of long-term, gulfside shoreline change history for the 109 year period between 1887 and 1996 (Table 1; Plate 6), the shore-perpendicular transects measured changes that ranged between +798 m at the prograding west end of Timbalier Island and -2685 m at the east end of East Timbalier Island. This was an average change of -1084 m at an average rate of -9.9 m/yr for the Timbalier barrier island arc shoreline. Timbalier Island experienced shoreline changes between +798 m and -1132 m with an average change of -147.8 along the Gulf shoreline, for an average rate of change of -1.4 m/yr. The highest rates of shoreline erosion occurred where East Timbalier Island migrated to the northwest. The erosion at East Timbalier Island was measured between -1657 m and -2685 m with the astounding average measurement of -2229.1 m. The average annual rate of change for this 109-year period for East Timbalier Island was -20.5 m/yr.

In terms of short-term shoreline change for the 8.9-year period between 1988 and 1996 (Table 1; Plate 5), the island arc experienced less western migration and more edge erosion, probably due to the severe hurricane impact sustained in 1992. The measurements of gulfside shoreline change along the Timbalier Barrier Island arc ranged between +100 m at the western end of Timbalier Island to -480 m at the east end of Timbalier Island with an average of -93.9 m. Although Timbalier Island measured both extremes, East Timbalier Island experienced higher consistent gulfside shoreline erosion. East Timbalier Island measurements ranged between -15 m where the shoreline was sheltered by the rock seawall and -465 m where the seawall failed and the shoreline retreated to the next rock seawall. Timbalier Island had an average shoreline change measurement of -44.6 m with and average rate of shoreline change of -4.8 m/yr. East Timbalier Island had an average shoreline change measurement of -152.9 m for an average rate of shoreline change of -17.2 m/yr.

Previous work by McBride and others (1992) for the Timbalier Islands documented a long-term (1887- 1988) gulfside change rate of -15.2 m/yr and a short-term (1978-1988) gulfside change rate of -14.0 m/yr (Table 2). Between 1887 and 1996, the average rate of gulfside shoreline change for the Timbalier barrier island arc was -9.9 m/yr. Comparing 1988 and 1996 for the new short-term gulfside change rates, the amount of gulfside shoreline change ranged between +100 m and -480 m with an average of -93.9 m with the new short-term gulfside change rate of -10.3 m/yr. Although the rates of erosion are still high, our new analysis indicates that the long-term rate of erosion has decelerated by 5.0 m/yr since 1988. The new longterm erosion rate has also decelerated from -23.1 m/yr (1887-1988) to -20.5 m/yr (1887-1996).

BAYSIDE SHORELINE CHANGES

In terms of long-term shoreline change history for the 109 year period between 1887 and 1996, the measurements of bayside shoreline change is difficult to analyze along the entire length of the Timbalier barrier island arc because of the tremendous lateral migration of the islands. The changes ranged between +2953 m at the retreating east end of East Timbalier Island and -1403 m at the east end of Timbalier Island where a large area of mangroves was lost during a freeze. The average shoreline change for the Timbalier barrier island arc shoreline was +950.8 m of landward migration at an average rate of +8.7 m/yr. For the small area that could be compared statistically at Timbalier Island, the bayside shoreline changes measured between -149 m and -1403 m with an average change of -606.4 m. The average long-term bayside rate of change at Timbalier Island was -5.6 m/yr. The bayside shoreline changes at East Timbalier Island was measured between +1590 m and +2953 m with the astounding average measurement of +2352.4 m as a result of landward island migration. The average annual bayside rate of change for this 109 year period for 6 East Timbalier Island was +21.6 m/yr.

In terms of short-term shoreline change for the 8.9 year period between 1988 and 1996, the island arc experienced less migration and more edge erosion along the bayside shoreline, probably due to the severe hurricane impact sustained in 1992 and the rock seawall along East Timbalier Island. The measurements of bayside shoreline change along the Timbalier Barrier Island arc ranged between +437 m at Timbalier Shoal to -514 m at the center of Timbalier Island with an average of -71.9 m. The bayside shoreline changes at Timbalier Island ranged between +28.3 m as the west spit migrated landward and -57.6 m in the center of the island, for an average bayside shoreline change measurement of -67.7 m. The average rate of bayside shoreline change at Timbalier Island was -7.6 m/yr.

Previous work by McBride and others (1992) for the Timbalier Islands documented a long-term (1887- 1988) bayside change rate of +11.7 m/yr and a short-term (1978-1988) bayside change rate of -7.8 m/yr (Table 3). Between 1887 and 1996 for the new long-term rate, the average rate of bayside shoreline change for the Timbalier barrier island arc was +8.7 m/yr. Comparing 1988 and 1996, the new short-term bayside change rate was -8.3 m/yr. Our new analysis indicates that the long-term landward migration has given way to short-term shoreline edge-erosion. The long-term bayside shoreline change rate for the Timbalier barrier island arc has decelerated from +11.7 m/yr (1887-1988) to +8.7 m/yr (1887-1996) which indicates an overall slowing of landward migration. The short-term bayside shoreline change rate has increased from -7.8 m/yr (1978 - 1988) to -8.3 m/yr

(1988-1996) which indicates an increase in bayside erosion.

AREA CHANGES

Area changes of the Timbalier barrier island arc have been dramatic since 1887. Between 1887 and 1996, the Timbalier barrier island arc decreased from 4125 acres to 1442 acres at a rate of -24.6 acres per year (a/yr) (Table 4). If this long-term rate of area loss continued working on the area measured in 1996, it forecasts a disappearance date of 2055. Previously in McBride and others (1992), the Timbalier island barrier arc decreased in area at a rate of -22.0 a/yr between 1887 and 1988, suggesting the long-term date of disappearance based on the 1988 island area would be 2076 (Table 5). The small increase in the longterm rate of land loss was calculated to shorten the life of the Timbalier barrier island arc by 21 years. The previous short-term rate of area loss for the Timbalier barrier island arc between 1978 and 1988 was - 176.7 a/yr, probably due to the loss of mangrove swamp by severe freezes and heavy hurricane and winter storm impacts. Between 1988 and 1996, the rate of land loss was still high but had slowed to -46.2 a/yr. The predicted disappearance date forecast by these rates changed from 1999 to 2027, increasing the life of the barrier islands by 28 years.

At the long-term rate of -22.0 a/yr, 1.2% of the 1988 landscape was expected to disappear per year. At - 24.6 a/yr, 1.7% of the 1996 landscape was expected to disappear per year. At short-term rates of -176.7 a/yr, 9.5% of the 1988 landscape was being lost per year, and at -46.2 a/yr, 3.2% of the 1996 landscape was being lost per year.

Between 1887 and 1996, Timbalier Island decreased from 3652 acres to 1114 acres at a rate of -23.3 a/yr (Table 4). This long-term rate of area loss acting on the area of Timbalier Island in 1996 forecasts a disappearance date of 2044. Previously in McBride and others (1992), Timbalier Island decreased in area at a rate of -23.0 a/yr between 1887 and 1988, suggesting the long-term date of disappearance would be 2046 (Table 5). The very small decrease in the long-term rate of land loss was calculated to lengthen the life of Timbalier Island by 2 years. The previous short-term rate of area loss for the Timbalier Island between 1978 and 1988 was -112.9 a/yr, and had a predicted disappearance date of 2000. This high rate of land loss was probably due to heavy hurricane and winter storm impacts, a severe freeze that killed the black mangrove swamp, and partly due to the direct removal of area by the construction of canals. Between 1988 and 1996, the rate of land loss had slowed significantly to -20.9 a/yr. The predicted disappearance date calculated by these rates changed from 2000 to 2049, increasing the life of Timbalier Island by 49 years.

East Timbalier Island increased in area from 1887 until approximately 1978 when it began to experience a cumulative land loss. Previously in McBride and others (1992), the East Timbalier Island increased in area at a long-term area change rate of +1.0 a/yr between 1887 and 1988, and therefore had no predicted date of disappearance (Table 5). Between 1887 and 1996, East Timbalier Island experienced a cumulative decrease in area from 473 acres to 300 acres at a rate of -1.6 a/yr (Table 4). This long-term rate of area loss forecasted a disappearance date of 2184. The previous short-term rate of area loss for the barrier island arc between 1978 and 1988 was -63.5 a/yr, probably due to heavy hurricane and winter storm impacts, and partly due to the direct removal of area by the construction of canals. Between 1988 and 1996, the short-term rate of land loss slowed to -26.2 a/yr. The predicted disappearance date for East Timbalier Island calculated by these rates changed from 1997 to 2007

SUMMARY

The Timbalier barrier island arc has historically exhibited high rates of lateral and landward migration with varying rates of area loss. Longshore sediment transport and across-island overwash has kept the islands moving but generally healthy, up until the last few decades. The previous short-term data for 1978 to 1988 documented exceptionally high landloss rates that have since slowed for the short-term data documented for 1988 to 1996. The new short-term rates of land loss are still close to double the long-term average.

A comparison of the previous and new long-term shoreline change rates for the Timbalier barrier island arc show that the general trend of island migration has slowed, while the loss of land area has increased. The gulfside shoreline is not eroding as rapidly and the bayside is not prograding as quickly as previous data indicated, with a increase in rate of land loss.

For short-term changes, the short-term gulfside shoreline erosion rates of 1988-1996 have slowed since the erosion rates documented during 1978-1988, while the bayside short-term erosion rates have increased.

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DISCLAIMER

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